W. B. No. 579.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.
CHARLES F. MARVIN, Chief.

INSTRUCTIONS TO SPECIAL RIVER AND RAINFALL OBSERVERS.

BY

ALFRED J. HENRY,
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WASHINGTON:
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NOTE TO OFFICIALS IN CHARGE OF DISTRICT CENTERS.

In general the instructions for Weather Bureau officials in charge of river district centers will be found in Station Regulations. There has been included in this pamphlet, however, some matter that is closely related to the work of the district center, yet is scarcely appropriate to Station Regulations, as, for example, the paragraphs on rain gage and on river gages in general.

Special attention is directed to the insert sheets at the end of the pamphlet. These sheets are designed to carry the specific instructions from the district center to the river or rainfall observer as to when to use the telegraph, etc. It is expected that each district center will complete a set of insert sheets for every river or rainfall observer in his district and attach the sheets to the gummed stubs at the end of the pamphlet. A duplicate set should be retained at the district center and additional specific instructions may be added from time to time by forwarding new insert sheets.

NOTE TO RIVER AND RAINFALL OBSERVERS.

This book of instructions will be carefully preserved. When an observer is relieved he will turn it over to his successor, obtaining the latter's receipt therefor, which will be forwarded by mail to the official in charge of the district.

LIST OF ILLUSTRATIONS.

1. An 8-inch rain gage.
2. Rain gage and box support.
3. Vertical staff gage.
4. Inclined river gage.
5. Vertical gage painted on a bridge pier.
6. Enameled scale gage.
7. Chain and weight gage, short box pattern.

INSTRUCTIONS

FOR

SPECIAL RIVER AND RAINFALL OBSERVERS.

OBJECT OF RIVER AND RAINFALL OBSERVATIONS.

The river and rainfall stations of the Weather Bureau are maintained primarily for the purpose of giving warning of the approach, magnitude, and duration of high waters, and for forecasting water stages at all heights, in the interest of navigation on the inland waterways of the country. The river and precipitation data are also of great value to various other interests, particularly to those concerned with the problems of irrigation and water supply.

DISTRICT CENTERS.

For the better supervision and control of the work, the special stations are arranged in districts. These districts are under the direction of officials at regular meteorological stations of the Weather Bureau, designated as district centers.

All correspondence relating to the work of substations, such as the furnishing of supplies, renewal of gages, settlement of accounts, and employment of observers, should be conducted through the official in charge at the district center to which the station is assigned. In the case of a combined station the official in charge of the river district will communicate direct with the station on matters connected with river work, but he will furnish copies of all important correspondence to the section director or other official who is also concerned in the work of the combined station.

Persons accepting positions as special river and rainfall observers of the Weather Bureau become authorized agents of the United States, and are amenable to the laws in case of neglect of duty.

Records of river stages.—The records of stages are preserved at Washington and printed from time to time. They are accessible at Washington, D. C., river district centers, and at Weather Bureau stations in the larger cities.

SUPPLIES.

Supplies of blank forms, franked and addressed envelopes, rain gages, measuring sticks, and other necessary supplies are furnished

to observers upon application to the official in charge of the district center. Timely requisition will be made for such supplies as are needed, and the needs of the station must be so anticipated as to allow ample time for the delivery of the articles from the central office at Washington, D. C., through the district center. One month is usually sufficient for this.

PROPERTY.

If the river gage is the property of the Weather Bureau, it is under the direct care of the river observer, but it will not be repaired or changed in any manner without the consent of the official in charge of the river distict.

Advise the district center whenever the gage needs repairs. It is important that the gage be kept in good repair and well painted.

Advise the district center promptly, by telegraph, if serious, of any damage to the gage that affects the accuracy of the readings.

If the gage is not the property of the Weather Bureau, it is important that the observer inform the district center of any repairs or changes made or when repairs are necessary.

When property and supplies are furnished to an observer, an itemized receipt therefor will be immediately mailed to the official in charge of the district.

When an observer is relieved from charge of a station, he will make out a list in triplicate of all Government property in his possession, and append at the bottom thereof the following certificate:

(*Date*) ——— ———, 19—.

I certify that I have this day received from ——— ——— (*name of former observer*) the above-mentioned articles in good condition unless otherwise specifield hereon.

(*Name of new observer*) ——— ———.

One copy of this report will be mailed to the official in charge of the district, one given to the new observer, and the third retained by the retiring observer.

When from any cause any article of property becomes unserviceable or in need of repairs, the fact must be at once communicated to the official in charge of the district, for such action as he may deem proper and necessary.

INSTRUCTIONS.

The duties of a river observer consist in noting on a form furnished for the purpose—

(1) The height of water on the gage, with change in 24 hours.

(2) Depth of rain or melted snow, with times of beginning and ending.

(3) Actual depth of snow, if any, since last observation.
(4) Direction of wind.
(5) State of weather.
(6) Depth of snow, if any, on ground on 15th and last day of month; also date on which last snow of season disappeared.
(7) Stage of river at crest of each flood, with hour of day, should it not occur at time of regular observation.

Detailed instructions as to the manner of keeping the records of river stages and the weather will be found on the back of Form No. 1006–Met'l.

A postal card—Form 1049–Met'l—must be carried to the river gage and the readings entered thereon *as soon as made.* On the last day of the month this card, which is the original record of the daily stages of water in the river, will be mailed to the district center, except that the following stations will forward the form to the central office at Washington: Keokuk, St. Louis, Memphis, Vicksburg, New Orleans, Cincinnati, Cairo, Nashville, Johnsonville, Kansas City, Little Rock, and Shreveport.

Telegraphic reports are also made under certain special conditions, as hereinafter described.

Rainfall observers.—The duties of a rainfall observer consist in noting on a form furnished for the purpose—

(1) The depth of rain or melted snow, with times of beginning and ending.
(2) Actual depth of snow, if any, since last observation.
(3) Direction of wind.
(4) State of weather.
(5) Depth of snow, if any, on ground on 15th and last day of month.

Telegraphic reports are also made under certain conditions, as hereinafter set forth. (See insert page at end of pamphlet.)

FORMS FOR RECORDING OBSERVATIONS.

Form 1006, Met'l.—The record of the observations made at the station for the month should be filled up in accordance with the instructions printed on the back of the form.

The form should be mailed to the official in charge of the district center on the first day of the succeeding month.

Before mailing, a copy must be made by the observer in the book furnished for that purpose.

At stations supplied with books of Form 1006, Met'l, on thin (onion-skin) paper, three copies of the form will be prepared. The first two or top copies of the form will be mailed to the district center and the last copy will be left in the book and will constitute

the retained record of the river station. (Four or five copies can be prepared by using a hard indelible lead pencil, if special conditions at a station should require more than three.)

The descriptive data at the head of Form 1006–Met'l will be carefully entered each month and will be verified at the district center; particular care being taken to see that the name of the station, month, and year, and name of the observer are properly entered. Means will not be computed for less than 15 days.

Form 3024, Tel.—For telegraphing reports in accordance with instructions hereinafter given.

Form 1084, Met'l (postal card).—For reporting the daily observations to the official in charge of district center or to other officials when required.

TELEGRAPHIC REPORTS.

As a general rule, whether or not river stages will be telegraphed to the district center daily depends on the value of the reports, either for the purpose of issuing flood warnings or in the interests of navigation. Instructions as to when the telegraph or telephone shall be used will be found on the insert sheets at the end of this pamphlet.

In telegraphing a report of heavy precipitation to the district center the telegram should be sent immediately when the heavy rain ceases. Do not wait until the time of the regular daily telegram. At stations telegraphing daily the morning telegram should include the total 24-hour rainfall, although a part of it may have been reported in a special observation.

Telegraphic reports will contain the fullest information possible within a limit of 20 words, including the address and signature.

Reports for telegraphic transmission will be written on Form 3024 Tel., in the following order: First, the word "observer"; second, name of the place to which the report is to be telegraphed; third, name of station from which report is telegraphed; fourth, time of observation, *if other than the time of the regular morning observation;* fifth, stage of river; sixth, tendency of river, as "rising," "falling," "stationary," as the case may be; seventh, state of weather, "clear," "partly cloudy," "cloudy," "raining," "sleeting," "snowing"; eighth, depth of rainfall; ninth, depth of unmelted snow, in inches (in case of no precipitation, add the word "none"); tenth, special remarks, such as "floating ice," "heavy loss of crops and stock," "frozen," or any other information of value; eleventh, surname of the observer.

Reports of regular morning observations should not contain the time word in the telegram.

The direction of the wind will not be sent, unless specially called for by the official in charge of the district center.

The rising or falling tendency of the water should indicate the condition at the actual time of the observation and not with reference to the preceding observation. For instance, the river may have been rising for several days and it may be higher than at any preceding regular observation, but it may have started to fall. In such an event telegraph "falling."

The reports should be carefully and legibly written in letters that can not be misunderstood. Observers are advised to write messages, whenever possible, in print letters instead of a running hand. The actual stage of the river in feet and tenths of a foot will be spelled out, as "twenty-four feet six," "twenty-two feet," etc.; the rainfall in inches and hundredths of an inch will be spelled out, as "one inch twenty-two," "three inches five," etc. The word "rising" or "falling," coming between the stage of water and the amount of rainfall, will prevent mistakes by confusing the tenths of a foot with the inches of rainfall. When less than 1 inch of rainfall is to be reported, the word "hundredths" should be added, as "seventy-four hundredths," "six hundredths," etc.

Messages should be filed at the telegraph office as soon as practicable after the observation has been taken. One copy of the telegram will be given to the operator at the telegraph office and one copy retained by the observer.

The following are examples of telegraphic reports:

1. Telegram from an observer who reports each morning by telegraph:

HERMANN, MO., *March 1, 1915.*

OBSERVER, *St. Louis, Mo.:*
Hermann, sixteen feet three stationary clear none.

JONES.

[Translation.]

Observer, St. Louis, Mo_____Address of Weather Bureau observer at St. Louis, Mo.
Hermann_____Name of river station at Hermann, Mo.
Sixteen feet three_____Stage of river, 16.3 feet.
Stationary_____River stationary at time of observation.
Clear_____State of the weather.
None_____No precipitation.
Jones_____Surname of river observer.

2. Telegram from an observer taken at a time other than the regular morning observation hour:

APRIL 30, 1914.

OBSERVER, *Memphis, Tenn.:*
Helena two p. m. minus two feet eight falling clear none.

BROWN.

[Translation.]

Observer, Memphis, Tenn——Address Weather Bureau observer at Memphis, Tenn.
Helena——Name of river station at Helena, Ark.
Two p. m——Time of observation, 2 p. m.
Minus two feet eight——Stage of river, —2.8 feet, or 2.8 feet below the zero mark on the gage.
Falling——River falling at time of observation.
Clear——State of weather.
None——No precipitation.
Brown——Name of river observer.

3. Telegram containing regular morning observation, with information as to crest of flood:

MARCH 20, 1914.

OBSERVER, *Memphis, Tenn.:*

Helena forty one feet two cloudy one inch two highest forty one feet six about 8 p. m.

BROWN.

[Translation.]

Observer, Memphis, Tenn——Address Weather Bureau observer at Memphis, Tenn.
Helena——Name of river station at Helena, Ark.
Forty one feet two——Stage of river, 41.2 feet.
Cloudy——State of weather.
One inch two——Precipitation, 1.02 inches.
Highest forty one feet six——Crest of flood, 41.6 feet.
About 8 p. m——Crest occurred about 8 p. m.
Brown——Name of observer.

4. Telegram from an observer who does not send daily observations by telegraph:

APRIL 3, 1915.

OBSERVER, *Cincinnati, Ohio:*

Charleston 10 a. m. twenty nine feet three rising rapidly snowing thirty two hundredths ice gorge half mile below.

JONES.

[Translation.]

Observation taken at 10 a. m.
Stage of river, 29.3 feet; rising rapidly.
Snowing; precipitation, 0.32 inch.
Ice gorge half mile below.
Jones, river observer.

5. Telegram from an observer who does not send daily observations by telegraph:

APRIL 7, 1915.

OBSERVER, *Pittsburgh, Pa.:*

Sharon 8 a. m. nine feet two rising rapidly raining two inches twelve bottoms beginning to flood.

BROWN.

[Translation.]

Observation taken at 8 a. m.
Stage of river 9.2 feet; rising rapidly.
Raining; precipitation 2.12 inches.
River bottoms beginning to flood.

Special observations.—Special observations will be made in accordance with the instructions on the insert sheets in the back of this pamphlet. They will be prepared according to the instructions on page 12, examples 4 and 5.

A statement of *all* observations telegraphed will be entered on Form 1006, under "remarks," giving the day and the hour taken. Failure to record extra observations or the fact that observations were telegraphed for which compensation is claimed will necessitate suspending payment until the discrepancies are explained.

With each important rise it is desired to have a special observation at the time of the highest water. If this can not be done, but the highest point reached by the river can be determined, it is desired that this be entered on Form 1006, giving the approximate time it occurred. In case the exact time of crest is not known, always enter "Approximately" after the time given.

Observations missed.—Regular morning observations missed will be deducted from the pay roll unless satisfactorily explained. The Chief of the Weather Bureau reserves the right to withhold payment from any person who persistently neglects to make his reports accurately and forward them promptly. Payment will be made quarterly.

Observations should, when possible, have substitutes capable of performing all the duties of a river observer in order that there may be no interruption of the work in case of sickness or unavoidable absence from the station on the part of the regular observer. Members of the observers' families are very often instructed in the work.

RAIN GAGE.

EXPOSURE OF RAIN GAGE.

The exposure of the rain gage is a very important matter. The most serious disturbing effecting in collecting rainfall is the wind. In blowing against the gage the eddies of wind formed at the top and about the mouth of the gage carry the rain away, so that too little is caught.

Observers will take particular care in selecting a good place for the location of a gage, as the value of the records is sometimes greatly

impaired by improper exposure. It is scarcely necessary to say that every precaution should be taken to protect gages from the interference of animals and unauthorized persons. Select, if possible, a position in some open lot as unobstructed as possible by trees, buildings, or fences. Such a place, in general, affords the best exposure.

INSTRUCTIONS FOR THE USE OF THE RAIN GAGE.

Description of gage.—The rain gage consists of the following parts: The receiver *A;* the overflow attachment *B;* the measuring tube *C.*

The top cylindrical portion of the receiver, marked *a*, see figure 1, is exactly 8 inches in diameter inside and is provided with a funnel-shaped bottom which conducts any precipitation falling into the receiver into the tall cylindrical measuring tube *C*, the total height of which, inside, is exactly 20 inches. The diameter of this tube is much smaller than the large receiving tube *a*, being only 2.53 inches. In consequence of this a small amount of rain falling into the receiver and flowing into *C* fills the latter to a depth greater than the actual rainfall in proportion as the area of the receiver is greater than the area of the measuring tube. In the standard gages of the Weather Bureau the depth of the rainfall, in accordance with this principle, is magnified just 10 times. The receiver *A* has a sleeve *d*, figure 1, which slips over the tube *C*, and very effectually prevents any loss of rainfall. Again, when the rainfall is very heavy the tube *C* may be more than filled. In this case, to still prevent loss, a little opening, shown at *e*, figure 1, is made in the sleeve *d*, just on a level with the top of the tube *C*.

The excess of rainfall escapes through this opening, and is retained in the large overflow attachment *B*, and can be measured afterwards, as will be described below. The diameter of the overflow attachment in the latest style gages is now made just 8 inches inside diameter. The object of this is to be able to use this portion of the instrument as a snow gage, as will be explained hereinafter.

RAIN GAGE AND SUPPORT.

The box in which the gage is shipped to the observer is expressly designed as a stand for the instrument, and should be opened at the head, which is fastened by screws. Set the box up as nearly vertical as possible at the place selected for the exposure and secure it in this position by driving down four stakes alongside, in the manner indicated in figure 2. Care must be taken to have the gage in a truly vertical position. Slip in the head and lower it to the level

of the screw holes in the sides of the box about 10 inches from the bottom, where the head will be securely fastened with the screws taken out in opening the box. The gage can now be placed inside and appears as shown in figure 2.

TO MEASURE RAINFALL AND SNOWFALL.

RAINFALL.

The rain-gage measuring stick is graduated into inches and tenths of inches. Remembering that the actual depth of the rainfall is

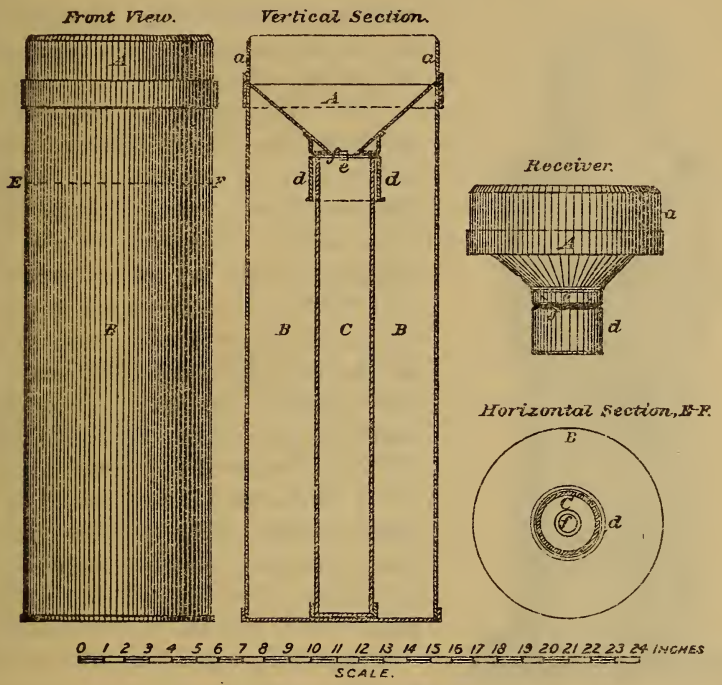

FIG. 1.—Rain gage.

magnified 10 times, as explained above, it is plain that if we find the water 10 inches deep in the measuring tube the real rainfall must have been only 1 inch deep; or if the water in the tube is only one-tenth inch (or, written as a decimal, 0.1 inch) deep the rainfall must have been only one one-hundredth inch (or, written as a decimal, 0.01 inch).

To save observers the trouble of always thinking about the magnification, and to avoid possible errors in reports, the numbers on the graduations of the measuring sticks are not actual inches, but have all been divided by 10, and thus represent the actual rainfall. Moreover, these numbers are expressed in hundredths of inches of

rainfall and are written as decimal fractions. Thus the 10-inch line is numbered 1.00 (read one and zero hundredths), which is the depth of rainfall in inches corresponding to 10 inches of water in the measuring tube; similarly, the 1-inch line is numbered 0.10 (read ten one-hundredths), which again is the depth of rainfall in inches corresponding to 1 inch of water in the tube.

The depth of the water is measured by inserting the measuring stick into the gage through the small hole in the funnel. When the stick reaches the bottom of the measuring tube it should be held for one or two seconds and then quickly withdrawn and examined to see at what division of the graduation the top of the wetted portion comes. The numbering of this division, *as stamped on the stick*, gives, as has just been explained, the actual depth of rainfall, and in making out records and reports observers should *always use the decimal expressions*. Of course, it will rarely happen that the top of the wetted portion will fall exactly upon one of the numbered lines—it will generally be on or near one of the shortest lines. Thus, for example, suppose the watermark comes to the sixth short line beyond the line numbered 0.80, the proper record to make in this case would be 0.86-inch rainfall. The number of short lines, reckoned from the numbered line next lower, are always to be inserted in place of the 0 in the standard numbers.

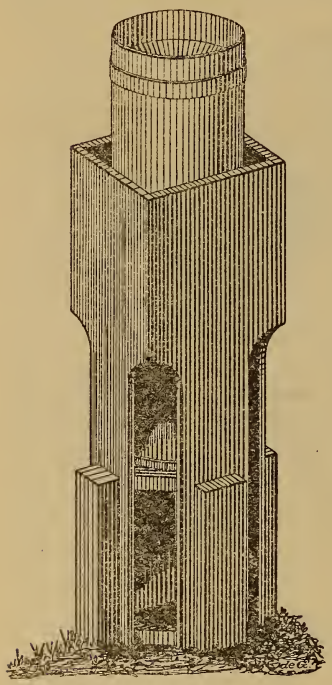

FIG. 2.—Rain gage and support.

Observers should always be careful to put the stick into the gage so that the end at which the numbering begins goes to the bottom and the stick passes through the middle of the tube; for if the stick is placed near the sides the water is sometimes drawn up by capillary action into the narrow space between the stick and the tube so as to wet the former entirely too high and give very erroneous records.

After measuring and recording in this way the precipitation found in the gage the top should be removed, the measuring tube emptied and drained, and the gage put in position again. Observers should be careful after emptying the gage to replace the measuring tube so that the bottom stands within the ring in the middle of the bottom of the

overflow, and in putting on the receiver to see that it passes over the measuring tube and rests squarely down upon the overflow.

When the amount of rain that has fallen more than fills the measuring tube some care is required to determine the total rainfall. First, carefully remove the receiver so as not to spill any of the water in the measuring tube, which should be exactly full. If some water has been slopped out and the measuring tube is not exactly full, the amount of water remaining must be accurately measured with the stick as already described. The tube is then lifted out slowly and carefully, if full, so as not to spill any of the water into the overflow, emptied, and allowed to drain a moment or so. The water remaining in the overflow is then poured into the measuring tube, care being taken not to lose any, and measured in the usual way. Suppose this is found to be 0.47 inch rainfall, then, remembering that the measuring tube contains just 2 inches, the total rainfall will be 2 inches plus 0.47 inch=2.47 inches. Or, in case some water was spilled from the measuring tube, the 0.47 inch should be simply added to the first measured amount to give the total rainfall.

SNOWFALL.

During the winter season, especially in those climates where the precipitation is nearly all in the form of snow, only the overflow attachment will be exposed in the support as a snow gage, removing the receiver and measuring tube to the house. These parts can not be used for measuring snow, and even if rain should occur it would be very apt to freeze and injure the measuring tube.

When the overflow collector is unprotected from the wind its catch represents the true amount of snow only in the case of precipitation during calms or very light winds. On windy occasions the catch is often highly inaccurate. The true quantity must be found, if possible, by measuring a section of the freshly fallen snow cut out by forcing the overflow, mouth downward, through the layer and then slipping a thin board or sheet of metal underneath so as to separate and lift up the section of snow thus cut out.

Assuming that a representative quantity of snow has been obtained in the overflow, a measurement may be secured by placing the vessel in a warm room until the snow has melted and then measuring the water in the measuring tube in the usual way.

The method just described is objectionable, owing to the time required and to the loss of the snow or water by evaporation. The following plan is much better: Take the overflow into the room and pour into it *one measuring tube full of water to the brim*, preferably warm. In cases of deep snowfall more water will be required. This

will melt, or at least reduce to a fluid slush, a considerable amount of snow. The measuring tube should then be filled to the brim from the melted contents of the overflow and emptied, thereby discarding a quantity of water equal to that added. The remaining water in the overflow, when measured in the tube, then gives the actual depth of melted snow.

In addition to this measurement by the gage a measurement will be made of the actual depth in inches of the snow on the ground. Select a level place of some extent, where the drifting is least pronounced, and measure the snow in at least three places. The mean of these measurements will give the snowfall, which is to be entered in the column of the report headed "Depth of snowfall in inches." Whenever it is impracticable to melt the snow as described in the preceding paragraph, one-tenth of this mean will give an approximate value, in water, for the snow which could not be melted. This value must be set down in the proper column of the report in precisely the same manner as rainfall or snow melted in the gage. After snowfall has once been measured, the same snow should not be measured at subsequent observations. Any fresh snow, however, should be measured and recorded.

Observations of rainfall should be made at the time of river observations, and the gage should be emptied of all the water it may contain as soon as it has been measured.

If no rain, snow, or hail has fallen during the period of observation, make the entry ".00" in the proper column. If the amount is too small to measure, make the entry "Trace" or "T."

It is particularly important, in the interest of accuracy, that the observations be recorded as soon as made and that the daily entries be made each day. Even if no rain has fallen, the observer should bear in mind that his official record of that fact is very important.

RIVER GAGES.

A river stage is the vertical height of the water flowing in a stream above or below a definite plane called the zero of the river gage. A river gage is a device for determining that height. It is very important that the zero of the gage be determined with great care. The best plane of reference is the bottom of flowing water in the stream. This point can be easily determined when there is a bar below the gage, since when the river is at a low stage there will be very little or no water flowing over the bar. The depth of water over the bar at the lowest point should be ascertained by soundings and the zero of the gage made to correspond thereto. In the absence of a bar it will be necessary to make a series of cross sections, or soundings, at and near the point selected for the gage, with a view of

determining the slope of the bottom of the river bed for a short distance both above and below that point.

When a gage is once established and a long record of readings has been made, it is not advisable to make any change in zero. In no case will the zero of a river gage be changed without the previous approval of the central office. The greatest care should be taken to maintain the absolute stability of all river gages. They should be carefully inspected from time to time with a view of discovering any possible changes due to settling, deviation from the perpendicular, stretching of chains and tapes, etc.

Bench marks.—For the purpose of ascertaining any changes that may occur in the level of the zero of a gage or any of its marks, from causes described above, a bench mark should be established close by the gage or somewhere in its immediate vicinity. A bench mark consists of some accessible, presumably permanent, point or surface, the difference in level between which and the zero or some other mark on the gage is known by actual leveling between the two. When this difference is found to vary it is presumed to indicate a corresponding change in the level of the marks of the gage, requiring either adjustment of the gage or correction of the readings. Such a difference will be reported immediately upon its discovery to the district center.

Suggested locations for a bench mark are: The top surface of a large stone in the top course of masonry on a bridge pier. Sometimes a bench mark is located in the top surface of a large stone buried in the ground specially for the purpose of establishing a permanent surface. Prominent surfaces in stone buildings are good places for permanent bench marks.

A copper bolt or metal plate set in the stone wall of some public building, such as the customhouse, post office, or city hall, is a common device for a bench mark in a large city.

The river gages used by the Weather Bureau are partly shown in figures 3, 4, 5, 6, and 7. The design best adapted to any particular location will be used in each case.

The specifications to be followed in procuring bids for the construction of these gages are as follows:

SPECIFICATIONS FOR RIVER GAGE SHOWN IN FIGURE 3.

The river gage will be made of sound pine or oak timber, free from knots or shakes, 2 inches in thickness, 12 inches in width, and of such a length as to extend, if possible, from 2 or more feet below the zero point to about 5 feet above the highest known water. The face of the plank upon which the graduations are to be made and the top, bottom, and sides will be planed smooth and will receive two coats

of the best white-lead paint. The face will then be graduated as follows:

Commencing at the point which will correspond to the zero, graduate the gage both above and below that point in feet and tenths of feet.

The graduations will be chiseled or burnt into the wood to the depth of about one-eighth of an inch and then given two coats of the best black paint. The marks for whole feet will extend entirely across the face of the gage; those for half-feet one-half the distance across, beginning on the left side, and those for the intermediate graduations one-fourth of the distance across, beginning on the left side. Whole feet will also be shown by the appropriate figures, 6 inches in height, on the right side of the gage, and so placed that the marks for whole feet will exactly bisect the figures. The figures will also be chiseled or burnt into the wood to the depth of about one-eighth of an inch, and then given two coats of the best black paint. An enameled plate with the legend, "U. S. Weather Bureau," will be fastened at the top of the gage. These can be obtained on stores requisition on the central office.

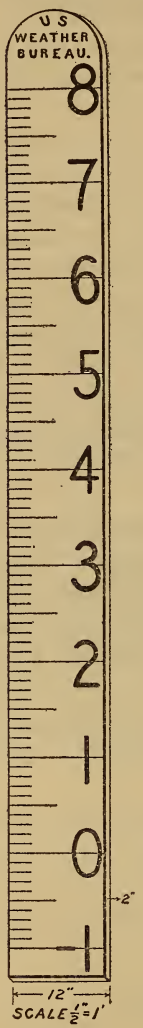

FIG. 3.

Having graduated the gage, select a pile or other stationary object on some portion of the levee, wharf, or bridge pier where the gage is to be installed, lower the gage into the water until its zero is exactly at the point selected as the zero of the river plane, taking care to keep it in a vertical position, then securely fasten it in this position by spikes or bolts.

SPECIFICATIONS FOR RIVER GAGE SHOWN IN FIGURE 4.

Procure a piece of pine, cypress, or oak timber about 6 by 6 inches, and of sufficient length to cover the full range of the river between extreme low and high water marks. This timber will be placed in the river bank, firmly embedded in the earth, leaving 1½ inches exposed above the level of the ground.

To secure this form of gage thoroughly it will be necessary to attach it to 4 by 6 or 6 by 6 inch oak, cedar, locust, or fir posts, driven

6 feet in the ground, and placed 6 feet apart. The upper edge of the gage should be planed smooth, and a strap of iron, ¼ by 2 inches screwed along the top on the upstream side, and graduated in feet and tenths of feet, after being placed in position, taking the point which has been selected as the zero of the scale, and locating the feet and tenths both above and below that point. The screw holes in the strap of iron, except the one near the middle, should be slightly elongated and there should be about one-tenth inch of space for every 10 feet on length left between the ends where two straps are joined so as to provide for the expansion of the iron without buckling. The graduations for this gage will be the same as for the gage shown in figure 3. Especial pains should be taken in graduating the gage to see that the distances marked off upon it for each

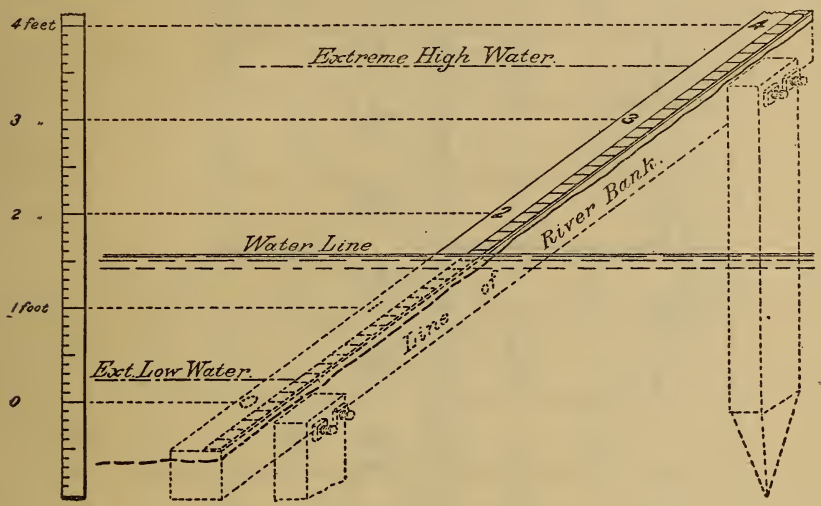

FIG. 4.

foot and its subdivisions correspond exactly to a vertical foot and its subdivisions of which it is a measure. This should be done by an engineer whenever possible.

It is also very desirable that this form of gage should have its top surface covered with two coats of the best white-lead or zinc paint, with the proper figures opposite the footmarks on the iron strap in black paint and not less than 4 inches in length. Figures should also be burnt in before painting, as permanent markings are thereby secured.

Specifications for an inclined gage of concrete construction should invariably be forwarded to the central office for aproval.

SPECIFICATIONS FOR RIVER GAGE SHOWN IN FIGURE 5.

Where a stone pier or abutment is available, a very durable gage can be made by dressing a face, 12 inches in width, from extreme low

water to as far above as may be necessary. The dressed surface should be covered with two coats of the best black paint, preferably asphaltum, after all holes and indentations in the pier have been filled with cement.

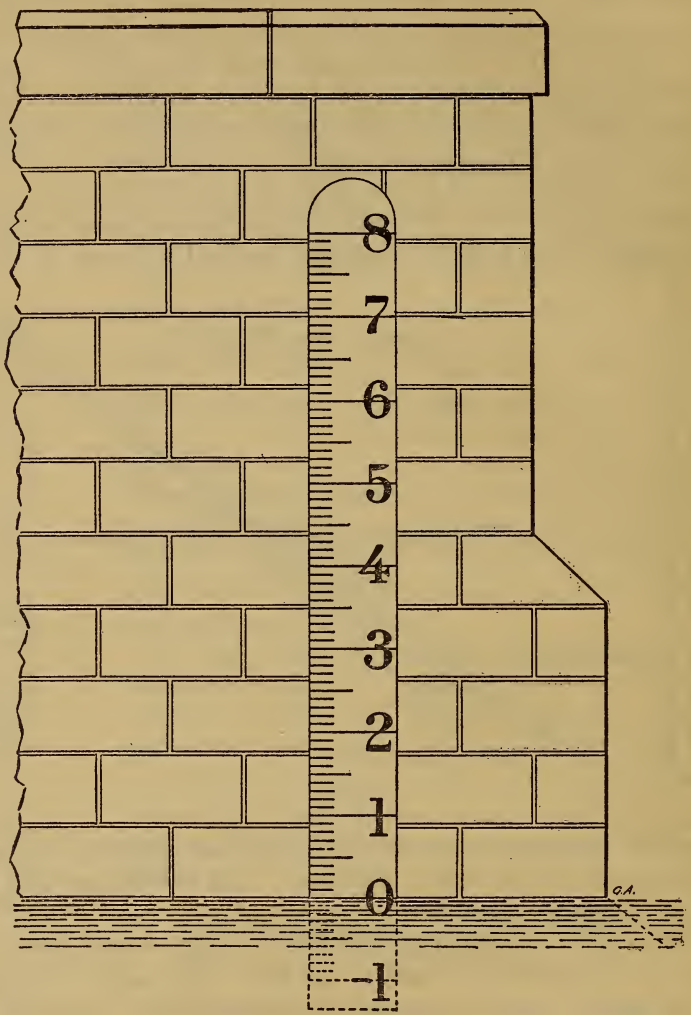

FIG. 5.

The space, both above and below the point at which the zero will be placed, will be graduated with two coats of the best white-lead or zinc paint into feet and tenths of feet. Markings for whole feet will extend entirely across the gage; those for half feet one-half the way across, beginning on the left side; and those for the intermediate graduations one-quarter of the way across, beginning on the left

side. All markings will be one-quarter of an inch in width. The figures for the whole footmarks will be in white, 5 inches in height, and the center of each figure must be over the foot line at the right. If the face of the pier is not vertical, care must be taken to see that the distance marked off for each foot and its subdivisions correspond exactly to a vertical foot and its subdivisions. The amount of the slope of the pier should also be reported.

THE ENAMELED SCALE GAGE.

This form of gage consists of numerals and graduated slabs or sections, which, being screwed upon a supporting timber, form the scale of a vertical staff gage. The advantages of the enameled scale are legibility and durability; it does not tarnish when exposed to the weather, and it may be washed off when mud accumulates on the lower section. The drawing below shows a section of the gage and its support. The width of the graduated section is 4 inches and of the integers 3 inches each; consequently the support must be 11 inches wide. The support should consist of 2 by 11 inch plank, preferably cypress, dressed on both sides, to be given a coat of raw linseed oil and then two coats of lampblack and oil. When practicable, battens of 2 by 4 stuff should be attached to the underside of the plank, but where the planks must be attached to the side of the pier the battens may be omitted. In making requisition for an enameled gage it is necessary to give the range in river stages the gage is to cover. The integers and graduated sections are attached to the timber support by screws.

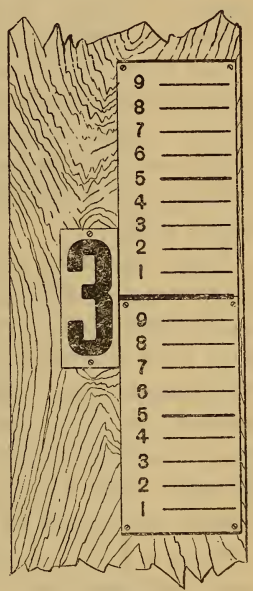

FIG. 6.

CHAIN-AND-WEIGHT RIVER GAGE.

SHORT BOX PATTERN.

The box is 2 feet long, 6 inches wide, 8 inches high on the back, and 5½ inches on the front. The hole for the down spout is in the center of the box, so that the scale may be placed on either side, although the scale provided is intended to be placed on the left side of the box. The enameled scale is in five sections, each 2½ feet long, and is graduated from 2½ feet below to 10 feet above zero. An inch board of sufficient length should be attached to the bridge rail in

order to bring the scale out flush with the slot in the end of the gage box.

The box should be securely fastened by its 8-inch side to the outside of the guard rail, or side of the bridge, the former preferred. If it should be necessary, a 2 by 8 inch plank of cypress or hard pine will be fastened to the bridge and the gage attached to this. Before attaching the box to the bridge the down spout should be screwed into the underside of the box so that the hole in the pipe is opposite the hole in the back of the box, and the bolt should be put through and bolted on the outside.

In placing the enameled scale, a careful measurement should be made from the zero of the scale to the 10-foot mark, to see that it is exactly 10 feet. It may be necessary to overlap the sections at the 5-foot point slightly in order to do this.

An open pulley is used in order that the chain and weight may be taken up into the box after each observation. The weight should be laid in the bottom of the box and the chain carefully piled from end to end of the box, care being taken not to lay the chain across the upper end of the down spout, in order to prevent its being tampered with.

When the zero of the river has been established the weight will be lowered so that its lower end just touches the zero point. The link of the chain directly opposite the zero mark on the scale will then have a rivet put into it and flattened on both sides, so that it will remain firm. Should it be necessary to record river readings beyond the scale limits, the rivet in the chain will be drawn up so that it will be exactly opposite the highest footmark on the scale. Another rivet will be placed in the link of the chain exactly opposite the zero mark of the scale and readings taken, using this second rivet as a base. A third rivet can also be added, if necessary. In recording readings which are beyond the scale limits, the second or third rivet will be used as a zero mark instead of the first, and there will be added to the observed reading the distance between the rivets—10, 20, 30 feet, etc., as the case may be. The weight is provided with an adjustable eyebolt, by which any slight error in the placing of the rivet may be corrected. The nut on the bolt should then be firmly tightened to prevent any change. If left loose, the weight is liable to get out of adjustment and thus cause an error in the readings.

In making requisition for gages, officials in charge of river districts will state the length of chain required.

The box attachments are sent complete, and the only materials to be supplied at the station are the bolts or screws for attaching the

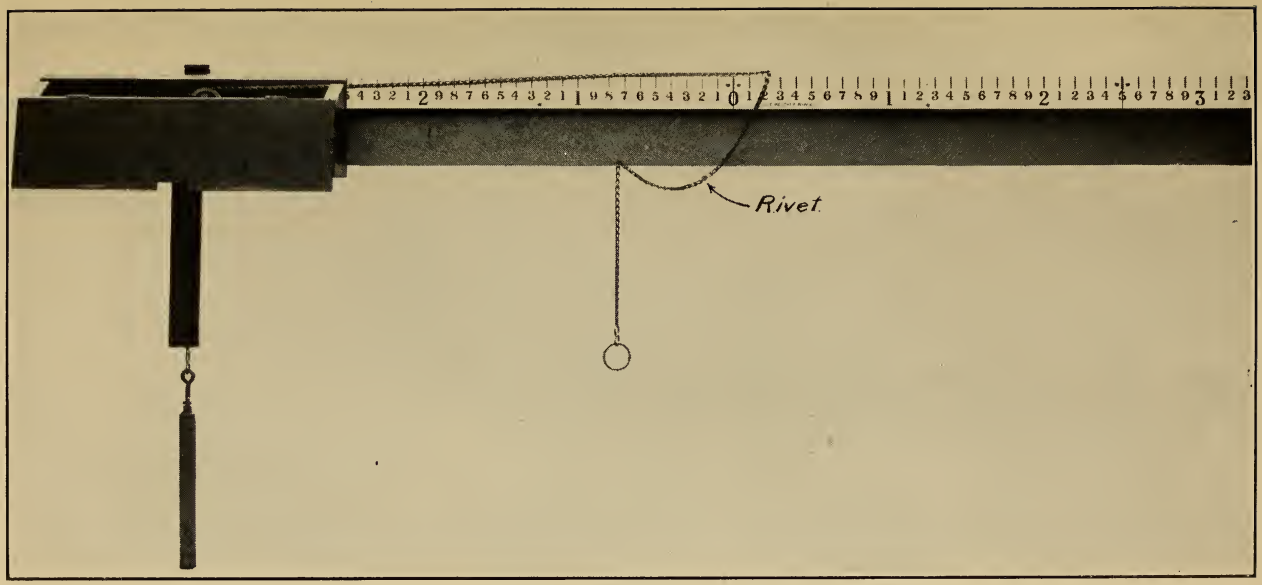

FIG. 7.

box to the bridge and a board and plank when needed. Figure 7 shows the chain and weight gage in place.

DESCRIPTION OF THE MOTT RIVER GAGE.

Box.—The gage box and doors are constructed of sand-dried oak lumber dressed on all surfaces, $\frac{7}{8}$-inch stock, and inside dimensions as follows: Height, 18 inches; width, 18 inches; depth, $7\frac{1}{2}$ inches.

Doors.—The box has two doors secured with extension hinges in such manner as to permit the doors to swing back against the sides of the galvanized-iron box. The entire outside surface of the box, excepting the bottom, and including the doors, is covered with No. 24 galvanized iron. The joints of the galvanized-iron cover are lapped and soldered, making the cover water-tight. The galvanized-iron cover of the box is painted with two coats of dark-green mineral paint, with a label on the doors of the box bearing the words "Property United States Weather Bureau. Penalty for Interference."

Lock.—The box is fitted with a brass mortise lock, using the same key as is used in the standard padlock for the chain and weight gages of the United States Weather Bureau and United States Geological Survey.

Mechanism.—The box is fitted with a tape reel consisting of an aluminum brake wheel and a brass spider, mounted on a turned cast-iron standard and fitted with a wooden handle. A leather brake strap and suitable levers for releasing the brake are provided. The brake strap is attached to a brass coil spring of sufficient strength to hold the weight and tape in any position. An iron guide wheel running on a turned axle, secured in the box by a cast-iron standard, is also provided.

Tape and gage.—The tape is made of phosphor bronze, one-fiftieth inch in thickness and one-fourth inch in width. It is nickeled throughout, excepting the relief in which the figures are etched, which is plain. The tape, accurately subdivided to feet, with foot marks numbered consecutively between such limits as may be necessary, is furnished with each gage. A 1-foot scale divided into 100 parts, and having every fifth division mark suitably numbered, is placed in the box so as to stand cornerwise back of the tape in a vertical position. This scale is made of No. 16 gage iron, enameled in black and white with six coats of enamel, and is attached to an iron bar which projects upward through the top of the box, the projecting end being covered by a cast-iron cap or cover attached to the box by screws, the object being to provide a suitable bench or reference mark outside the box.

The 1-foot scale is adjustable vertically. A standard weight is provided with each gage, together with a clip and wire for attaching the same to the tape.

Miscellaneous.—Each gage contains a covered compartment for the observer's record card, etc., instructions for erecting a gage in various positions, for attaching the weight, checking the gage datum, and operating the gage.

A rectangular wooden down spout, 16 inches in length, with screw for attaching the same, is provided with each gage.

Each gage is also provided with a screw driver and a $\frac{3}{8}$-inch twist drill for use in erecting the gage.

Operation.—Release brake and slowly unwind tape until weight reaches water. Do not run tape all out without holding reel handle. Brake will hold reel in position, and observer can stand to one side to see that tip of weight just touches water. Read number of whole feet on bronze tape and tenths of a foot on enameled scale. The figure on the tape standing opposite some part of the 1-foot scale gives the whole feet; the number of tenths and hundredths on the 1-foot scale opposite the index of the number on the tape gives the decimal or fractional portion of the gage reading.

For example, if the number 7 on the tape stands opposite 60 on the enameled scale, the gage reading would be 7.6 feet. If the number —2 feet (2 feet below zero) is opposite 74 on the enameled scale the reading is —2.26, recorded —2.3 feet (2.3 feet below zero)—1 foot —0.74 foot=0.26 foot, for the fractional part—the complete reading being —2.26. When the reading is below zero the number on the enameled scale opposite the figure on the tape will be subtracted from the number of whole feet recorded.

Erection.—The gage may be bolted to the handrail of a bridge, if not liable to interference, one side being fastened to tiebars that extend down to the floor of the bridge. It may also be secured to a platform extending beyond the handrail, the bottom of the box being on a level with the top of the rail. When there is no handrail, as on most railroad bridges, the gage may be bolted or secured to vertical bridge members, or it may stand on horizontal bridge chords, or be attached to two sleepers at their ends. In all cases room must be provided for the unobstructed movement of the weight.

A small supply of Mott gages, ready for installation, remains on hand at the central office and bids for installation will be necessary. These gages will be supplied where suitable for the local needs, but as a rule preference will be given to the chain and weight gage described on previous pages.

In each instance the exact distance from the zero stage of the water to the bottom of the gage box when in position must be furnished.

TABLE FOR CONVERTING INCHES INTO TENTHS OF A FOOT.

If the river gage is graduated in feet and inches, the inches will be converted into tenths of a foot by the following table before telegraphing:

1 inch of water equals one-tenth (0.1) of a foot.
2 inches of water equal two-tenths (0.2) of a foot.
3 inches of water equal two-tenths (0.2) of a foot.
4 inches of water equal three-tenths (0.3) of a foot.
5 inches of water equal four-tenths (0.4) of a foot.
6 inches of water equal five-tenths (0.5) of a foot.
7 inches of water equal six-tenths (0.6) of a foot.
8 inches of water equal seven-tenths (0.7) of a foot.
9 inches of water equal eight-tenths (0.8) of a foot.
10 inches of water equal eight-tenths (0.8) of a foot.
11 inches of water equal nine-tenths (0.9) of a foot.